The Conjugation of Spirogyra crassa Kg.

By Edwin Bingham Copeland

On an afternoon in September, 1900, the writer collected in a stagnant cut-off on Cheat River in West Virginia some *Spirogyra* so large that its conjugation was very evident to the naked eye. It was fixed in Flemming's fluid and preserved in alcohol. When it was examined and determined later, preliminary to class use, it was found to have some characteristics that are probably worth reporting.

Different species of *Spirogyra* vary in the intensity with which they possess distinct sexuality, as male or female plants. In all of them the cells show a difference in behavior, in that one is recipient, the other active, which is a marked advance over related genera in which the zygospore is formed midway between the gametes. But in some species the cells of a single filament conjugate in pairs, the conjugating tube passing around the transverse wall; in this case the filament as a whole is without sex. When the conjugation is between the cells of parallel filaments it is usually altogether in one direction, one filament acting as female and the other as male. But in such cases filaments sometimes occur which if traced far enough are found to bend about onto, and conjugate with, themselves, being female in one part, male in another. Such cases suggest that where a distinction of the sexes is just beginning to appear, sex may be a relative quality; if one part of a filament can be male with reference to another part as female, why might not a filament act as male with reference to one of its neighbors, but female with reference to another. In this *S. crassa* material sex is a positive quality of the filament. I have examined a great number of instances of polygamy and polyandry, cases in which a long filament conjugated at different places along its length with several others. I have never found a filament conjugating with itself, nor a single instance of a filament whose sex was not constant in its numerous alliances. Often three filaments were in contact, each with both the others; one would conjugate with both others indiscriminately, all the cells of both the others

starting to form conjugating tubes with it; but the two of like sex never stimulated each other even enough to make the tubes start to grow. The filaments are then completely dioecious, and their sex must be determined in the zygospore. Complete dioecism is a higher degree of sexuality than would be anticipated in plants whose gametes are not visibly different* except in their part in conjugation.

In much higher plants, likewise dioecious, the sex is not always as fixed as it seems here: thus Lesquereux and James † say of *Atrichum undulatum* Beauv.: "This species is dioecious, but sometimes the young male plant produces from the center of the flower an innovation bearing female flowers and thus the male plant is transformed into a fertile one."

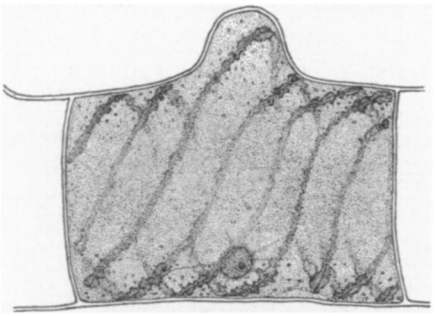
In the cells of the vegetative filaments the nuclei were large and centrally placed, the entire contents of the cells reasonably clear, and no unusual bodies to be seen in the chloroplasts. In cells which had progressed in conjugation to the meeting of the tubes there were usually some black granules in the chlorophyll bands, the body of the cell remaining as clear as ever. Where two filaments of one sex conjugated with one of the other, or where one filament of a pair had shorter cells than the other, there were cells which tried to conjugate but failed: some of these merely started to put out a conjugating tube, at other times this stimulated the development of a tube to meet it. In all of these cells the contents was discolored by the presence of distinct granules and of a diffused opacity. The shade varied from pale brown to deep black. The failure to conjugate has interfered in some way with the normal metabolism of the cells. Very likely it is that plastic matter intended for use in conjugation has accumulated as oil and has been blackened by the osmic acid. But it occurs in cells whose conjugating tube has completely formed. The pen drawing is made from a cell which failed to conjugate, and is drawn a little lighter in shade than is natural.

The position of the nucleus in conjugating cells was remarkable. A large part of my material was fixed at about the stage in

* Kny (Wandtafeln, Text, 11) says that the sex of filaments of his material—a large, not certainly identified species—was distinguishable by the shape of the cells, before conjugation began.

† Mosses of North America, 256.

conjugation when the wall between the tubes is absorbed: in all of it, in this stage and somewhat earlier, the nucleus was very constantly to be found close to the outer wall on the side *opposite* the conjugating tube. This could be seen in almost every conjugating cell. In the cells which failed to find mates the nucleus was more often invisible or obscured; but sometimes it was very evident, as in the cell drawn. In this position the nucleus is rather smaller and much less conspicuous than in vegetative cells.* This position of the nucleus is the opposite of that usually assumed in cells with local-



ized growth.† As is suggested in a recent paper by Miehe,‡ the central position of the nucleus in young and active cells, instead of a lateral one, even when growth is more or less localized, is easily understood in consideration of the various functions of the nucleus. But this is the first instance known to me of a nucleus that moved to the opposite wall. This species, *S. crassa*, has been studied in the same connection by Gerassimoff,§ but not during conjugation.

* Strasburger (Befructung und Zelltheilung, Jena, 5, 1878) says that early in the conjugation of *S. quinina* the nuclei become pale and disappear.

† Haberlandt. Ueber die Beziehungen zwischen Function und Lage des Zellkernes bei den Pflanzen. Jena, 1887. Physiologische Pflanzenanatomie. 2d Ed. 23–24. 1896.

‡ Ueber Wanderung des pflanzlichen Zellkernes, Flora, 88: 105–142. 1901.

§ Ueber die Lage und die Function des Zellkernes. Moscow, 1900.